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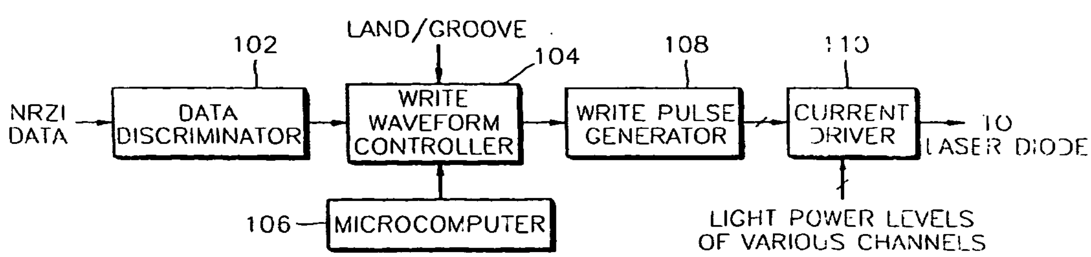
(54) Adaptive writing method and circuit for a high-density optical recording apparatus

(57) An adaptive writing method for a high-density optical recording apparatus and a circuit thereof are provided. The circuit includes a discriminator (102) for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces, a generator (104,108) for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and a driver (110) for driving the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels. The widths of the first and/or last pulses of a write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading and/or trailing spaces, thereby minimizing jitter to enhance system reliability and performance.

FIG. 2



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Description

[0001] The present invention relates to an adaptive writing method for a high-density optical recording apparatus and a circuit thereof, and more particularly, to an adaptive writing method for optimizing light power of a light source, e.g., a laser diode, to be suitable to characteristics of a recording apparatus, and a circuit thereof.

[0002] With the multi-media era requiring high-capacity recording media, optical recording systems employing high-capacity recording media, such as a magnetic optical disc drive (MODD) or a digital versatile disc random access memory (DVD-RAM) drive, have been widely used.

[0003] As the recoding density increases, such optical recording systems require optimal and high-precision states. In general, with an increase in recording density, temporal fluctuation (to be referred to as jitter, hereinafter) in a data domain increases. Thus, in order to attain high-density recording, it is very important to minimize the jitter.

[0004] Conventionally, a write pulse is formed as specified in the DVD-RAM format shown in Figure 1B, with respect to input NRZI (Non-Return to Zero Inversion) data having marks of 3T, 5T and 11T (T being the channel clock duration), as shown in Figure 1A. Here, the NRZI data is divided into mark and space. The spaces are in an erase power level for overwriting. The waveform of a write pulse for marks equal to or longer than 3T mark, that is, 3T, 4T,...11T and 14T is comprised of a first pulse, a last pulse and a multi-pulse train. Here, only the number of pulses in the multi-pulse train is varied depending on the magnitude of a mark.

[0005] In other words, the waveform of the write pulse comprises a combination of read power (Figure 1C), peak power or write power (Figure 1D) and bias power or erase power (Figure 1E). Here, the respective power signals shown in Figures 1C, 1D and 1E are all low-active signals.

[0006] The waveform of the write pulse is the same as that in accordance with the first generation 2.6 GB DVD-RAM standard. In other words, in accordance with the 2.6 GB DVD-RAM standard, the waveform of the write pulse is comprised of a first pulse, a multi-pulse train and a last pulse. Although the rising edge of the first pulse or the falling edge of the last pulse can be read from a lead-in area to be used, adaptive writing is not possible since the write pulse is fixed to be constant.

[0007] Therefore, when a write operation is performed by forming such a write pulse as shown in Figure 1B, severe thermal interference may occur back and forth with respect to a mark in accordance with input NRZI data. In other words, when a mark is long and a space is short or vice versa, jitter is most severe. This is a major cause of lowered system performance. Also, this does not make it possible for the system to be applied to high-density DVD-RAMs, e.g., second generation 4.7 GB DVD-RAMs.

[0008] It is an aim of the present invention to provide an adaptive writing method for generating a write pulse taking account of the magnitude of the present mark of input data and the magnitudes of the leading and/or trailing spaces thereof.

[0009] It is another aim of the present invention to provide an adaptive writing circuit for a high-density optical recording apparatus for optimizing light power of a laser diode by generating an adaptive write pulse.

[0010] According to the present invention there is provided an adaptive writing method according to any one of claims 1, 9 or 14 appended hereto. Also according to the present invention there is provided an adaptive writing circuit as set forth in claim 20 appended hereto. Preferred features of the present invention will be apparent from the dependent claims and the description which follows.

[0011] According to a first aspect of the present invention there is provided a method for writing input data on an optical recording medium by a write pulse whose waveform is comprised of a first pulse, a last pulse and a multi-pulse train, the adaptive writing method including the steps of controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and writing the input data by the adaptive write pulse on the optical recording medium.

[0012] Preferably, the method includes the step of generating an adaptive write pulse in which the rising edge of the first pulse is varied in accordance with the magnitude of the leading space and the magnitude of the present mark. Preferably, the falling edge of the last pulse is varied in accordance with the magnitude of the present mark and the magnitude of the trailing space. Ideally, the rising edge of the first pulse is varied in accordance with the magnitude of the leading space and the magnitude of the present mark, and the falling edge of the last pulse is varied in accordance with the magnitude of the present mark and the magnitude of the trailing space.

[0013] Preferably, the method includes the step of generating an adaptive write pulse in which the rising edge of the first pulse is shifted back and forth in accordance with the magnitude of the leading space and the magnitude of the present mark, and the falling edge of the last pulse is shifted back and forth in accordance with the magnitude of the present mark and the magnitude of the trailing space.

[0014] Preferably, the light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse. Preferably, the light power for a predetermined channel is either read power or write power.

[0015] Preferably, the method comprises the step of correcting the waveform of the adaptive write pulse in

accordance with a land/groove signal indicating whether the input data is data of a land track or data of a groove track.

[0016] According to a second aspect of the present invention there is provided an apparatus for writing input data on an optical recording medium by a write pulse whose waveform is comprised of a first pulse, a last pulse and a multi-pulse train, the adaptive writing circuit including a discriminator for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces, a generator for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and a driver for driving the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

[0017] Preferably, the generator includes a write waveform controller for generating pulse width data for varying the width of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark and varying the width of the last pulse in accordance with the magnitude of the present mark and the magnitude of the leading space, and a write pulse generator for generating an adaptive write pulse in accordance with the pulse width data.

[0018] Preferably, the write waveform controller comprises a memory in which width data of the first and/or last pulses of a write pulse waveform are stored, by grouping the magnitude of the present mark and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group and a long pulse group.

[0019] Preferably, the apparatus comprises a microcomputer for initializing the write waveform controller and controlling the pulse width data stored in the memory to be updated in accordance with write conditions. Preferably, the memory stores width data of the first and/or last pulses of a write pulse waveform depending on whether the input data is in a land track or a groove track. Preferably, the memory stores width data of the first and/or last pulses of a write pulse waveform for the respective zones on a recording medium.

[0020] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figures 1A through 1E are waveform diagrams of conventional write pulses;

Figure 2 is a block diagram of an adaptive writing circuit for a high-density optical recording apparatus according to an embodiment of the present invention;

Figures 3A through 3G are waveform diagrams of an adaptive write pulse recorded by the adaptive writing circuit shown in Figure 2;

Figure 4 illustrates grouping of input data;

Figure 5 is a table illustrating the combination of pulses generated by the grouping shown in Figure 4;

Figure 6 is a table illustrating rising edge shift values of a first pulse;

Figure 7 is a table illustrating falling edge shift values of a last pulse;

Figure 8 is a flowchart of an adaptive writing method according to an embodiment of the present invention; and

Figure 9 is a graph for comparing jitter generated by the adaptive writing method of the present invention and the conventional writing method.

[0021] Hereinafter, a preferred embodiment of an adaptive writing method for a high-density optical recording apparatus and a circuit thereof will be described with reference to the accompanying drawings.

[0022] A preferred adaptive writing circuit, as shown in Figure 2, includes a data discriminator 102, a write waveform controller 104, a microcomputer 106, a write pulse generator 108 and a current driver 110. Suitably, the data discriminator 102 discriminates input NRZI data. The write waveform controller 104 corrects the waveform of a write pulse in accordance with the discrimination result of the data discriminator 102 and a land/groove signal. The microcomputer 106 initializes the write waveform controller 104 or controls the data stored in the write waveform controller 104 to be updated in accordance with write conditions. The write pulse generator 108 generates an adaptive write pulse in accordance with the output of the write waveform controller 104. The current driver 110 converts the adaptive write pulse generated from the write pulse generator 108 into a current signal in accordance with the light power levels of the respective channels to drive a light source.

[0023] Next, the operation of the apparatus shown in Figure 2 will be described with reference to Figures 3 through 7.

[0024] In Figure 2, the data discriminator 102 discriminates the magnitude of a mark corresponding to the present write pulse (to be referred to as a present mark), the magnitude of the front-part space corresponding to the first pulse of the present mark (to be referred to as a leading space, hereinafter) and the magnitude of the rear-part space corresponding to the last pulse of the present mark (to be referred to as a trailing space) from input NRZI data, and applies the magnitudes of the lead-

ing and trailing spaces and the magnitude of the present mark to the write waveform controller 104.

[0025] Here, the magnitudes of the leading and trailing spaces and the magnitude of the present mark may range from 3T to 14T. There can be more than 1,000 possible combinations. Thus, circuits or memories for obtaining the amounts of shift in rising edges of the first pulses and falling edges of the last pulses are necessary with respect to all cases, which complicates the system and hardware. Therefore, in the present invention, the magnitudes of the present mark and the leading and trailing spaces of input NRZI data are grouped into a short pulse group, a middle pulse group and a long pulse group and the grouped magnitudes of the present mark and the leading and trailing spaces are used.

[0026] The write waveform controller 104 shifts the rising edge of the first pulse back and forth in accordance with the magnitudes of the leading space and the present mark, supplied from the data discriminator 102, or shifts the falling edge of the last pulse back and forth in accordance with the magnitudes of the present mark and the trailing space, to thus form a write waveform having an optimal light power. Here, the multi-pulse train of a mark takes the same shape as shown in Figure 3B, that is, 0.5 T.

[0027] Also, the write waveform controller 104 can correct the rising edge of the first pulse of the present mark and the falling edge of the last pulse of the present mark into different values in accordance with externally applied land/groove signals (LAND/GROOVE) indicating whether the input NRZI data is in a land track or a groove track. This is for forming a write waveform in consideration of different optimal light powers depending on the land and groove. A difference of 1-2 mW in the optimal light powers between the land and the groove, and may be specifically set or managed by the specifications.

[0028] The write waveform controller 104 suitably comprises a memory to store data corresponding to a shift value of the rising edge of the first pulse and a shift value of the falling edge of the last pulse in accordance with the magnitude of the present mark of input NRZI data and the magnitudes of the leading and trailing spaces thereof. Alternatively, the waveform controller 104 suitably comprises a logic circuit. In the case that the write waveform controller 104 is constituted by a memory, the widths of the first pulse and the last pulse are determined as channel clocks (T) plus and minus a data value (shift value) stored in the memory. Also, in this memory, shift values of the first and last pulses of the mark for each of a land and a groove may be stored. A table in which the shift value of the rising edge of the first pulse is stored and a table in which the shift value of the falling edge of the last pulse is stored may be incorporated. Alternatively, as shown in Figures 6 and 7, two separate tables may be prepared.

[0029] A microcomputer 106 initializes the write waveform controller 104 or controls the shift values of the first and/or last pulse(s) to be updated in accordance with recording conditions. In particular, in accordance with zones, the light power can vary or the shift values of the first and last pulses can be reset.

[0030] The pulse width data for controlling the waveform of the write pulse is provided to the write pulse generator 108. The write pulse generator 108 generates an adaptive write pulse, as shown in Figure 3F, in accordance with the pulse width data for controlling the waveform of the write pulse supplied from the write waveform controller 104 and supplies control signals shown in Figures 3C, 3D and 3E, for controlling the current flow for the respective channels (i.e., read, peak and bias channels) for the adaptive write pulse, to the current driver 110.

[0031] The current driver 110 converts the driving level of the light power of the respective channels (i.e., read, peak and bias channels) into current for a control time corresponding to the control signal for controlling the current flow of the respective channels to allow the current to flow through the laser diode so that an appropriate amount of heat is applied to the recording medium by continuous ON-OFF operations of the laser diode or a change in the amounts of light. Here, a record domain as shown in Figure 3G is formed on the recording medium.

[0032] Figure 3A shows input NRZI data, which is divided into mark and space. Figure 3B shows a basic write waveform, in which the rising edge of the first pulse of the write pulse lags behind by 0.5T, compared to the rising edge of the present mark. Figure 3C shows the waveform of a read power of the adaptive write pulse, Figure 3D shows the waveform of a peak power of the adaptive write pulse, and Figure 3E shows the waveform of a bias power of the adaptive write pulse. Figure 3F shows the waveform of the adaptive write pulse proposed in the present invention. The rising edge of the first pulse of the write waveform of the adaptive write pulse may be shifted back and forth in accordance with a combination of the magnitude of the leading space and the magnitude of the present mark. An arbitrary power (here, a read power or a write power) is applied during the period corresponding to the shift. Likewise, the falling edge of the last pulse of the adaptive write pulse may be shifted back and forth in accordance with a combination of the magnitude of the present mark and the magnitude of the trailing space. Also, an arbitrary power (here, a read power or a write power) is applied during the period corresponding to the shift.

[0033] Alternatively, the falling edge of the last pulse may be shifted back and forth in accordance with the magnitude of the present mark, regardless of the magnitude of the trailing space of the present mark. Also, rather than shifting the rising edge of the first pulse and the falling edge of the last pulse, the edge of any one pulse may be shifted. Also, in view of the direction of shift, shifting may be performed back and forth, only forward or only backward.

[0034] Figure 4 illustrates grouping of input NRZI data, showing two examples of grouping. In the first example, if a low grouping pointer is 3 and a high grouping pointer is 12, then the mark of a short pulse group is 3T, the marks of a middle pulse group are from 4T to 11T and the mark of a long pulse group is 14T. In the second example, if a low grouping pointer is 4 and a high grouping pointer is 11, then the marks of a short pulse group are 3T and 4T, the marks of a middle pulse group are from 5T to 10T and the marks of a long pulse group are 11T and 14T. As described above, since both the low grouping pointer and the high grouping pointer are used, utility efficiency is enhanced. Also, grouping can be performed differently for the respective zones.

[0035] Figure 5 illustrates a number of cases depending on combinations of leading and trailing spaces and present marks, in the case of classifying input NRZI data into three groups, as shown in Figure 4, using grouping pointers. Figure 6 illustrates a table showing shift values of rising edges of the first pulse depending on the magnitude of the leading space and the magnitude of the present mark. Figure 7 illustrates a table showing shift values of falling edges of the last pulse depending on the magnitude of the present mark and the magnitude of the trailing space.

[0036] Figure 8 is a flow chart illustrating an embodiment of an adaptive writing method of the present invention. First, a write mode is set (step S101). If the write mode is set, it is determined whether it is an adaptive writing mode or not (step S102). If it is determined in step S102 that the write mode is an adaptive write mode, a grouping pointer is set (step S103). Then, a grouping table depending on the set grouping pointer is selected (step S104). The selected grouping table may be a table reflecting land/groove as well as the grouping pointer. Also, the selected grouping table may be a table reflecting zones of the recording medium.

[0037] Shift values of the rising edge of the first pulse are read from the table shown in Figure 7 in accordance with a combination of the present mark and the trailing space (step S106).

[0038] The adaptive write pulse in which the first pulse and the last pulse are controlled in accordance with the read shift value is generated (step S107). Then, the light powers of the respective channels for the generated adaptive write pulse, i.e., read, peak and bias powers, are controlled to drive a laser diode (step S108) to then perform a write operation on a disc (step S109). If the write mode is not an adaptive write mode, a general write pulse is generated in step S107.

[0039] Figure 9 is a graph for comparing jitter generated by the adaptive writing method according to the present invention and the conventional writing method. It is understood that, assuming that the peak light is 9.5 mW, the bottom power of a multi-pulse train is 1.2 mW, the cooling power is 1.2 mW and the bias power is 5.2 mW, there is less jitter generated when writing the adaptive write pulse according to the present invention than when generated writing the fixed write pulse according to the conventional writing method. The initialization conditions are a speed of 4.2 m/s, an erase power of 7.2 mW and 100 write operations.

[0040] As described above, in adaptively varying the marks of a write pulse, the rising edge of the first pulse is adaptively shifted in accordance with the magnitude of the leading space and the magnitude of the present mark of input NRZI data to thus control the waveform of the write pulse, and/or the falling edge of the last pulse is adaptively shifted in accordance with the magnitude of the present mark and the magnitude of the trailing space of input NRZI data to thus control the waveform of the write pulse, thereby minimizing jitter. Also, the waveform of the write pulse may be optimized in accordance with land/groove signals. Further, grouping may be performed differently for the respective zones, using grouping pointers.

[0041] The adaptive writing method described above can be adopted to most high-density optical recording apparatus using an adaptive writing pulse.

[0042] The widths of the first and/or last pulses of a write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading or trailing space, thereby minimizing jitter to enhance system reliability and performance. Also, the width of a write pulse is controlled by grouping the magnitude of the present mark and the magnitude of the leading or trailing spaces, thereby reducing the size of a hardware.

[0043] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0044] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0045] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0046] The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An adaptive writing method for use in writing input data onto an optical recording medium by a write pulse whose waveform comprises a first pulse, a last pulse and a multi-pulse train, the adaptive writing method comprising the steps of:

   (a) controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse; and

   (b) writing the input data by the adaptive write pulse on the optical recording medium.

2. The adaptive writing method according to claim 1, wherein the step (a) includes the step of generating an adaptive write pulse in which the rising edge of the first pulse is varied in accordance with the magnitude of the leading space and the magnitude of the present mark.

3. The adaptive writing method according to claim 1, wherein the step (a) includes the step of generating an adaptive write pulse in which the falling edge of the last pulse is varied in accordance with the magnitude of the present mark and the magnitude of the trailing space.

4. The adaptive writing method according to claim 1, wherein the step (a) includes the step of generating an adaptive write pulse in which the rising edge of the first pulse is varied in accordance with the magnitude of the leading space and the magnitude of the present mark, and the falling edge of the last pulse is varied in accordance with the magnitude of the present mark and the magnitude of the trailing space.

5. The adaptive writing method according to claim 1, wherein the step (a) includes the step of generating an adaptive write pulse in which the rising edge of the first pulse is shifted back and forth in accordance with the magnitude of the leading space and the magnitude of the present mark, and the falling edge of the last pulse is shifted back and forth in accordance with the magnitude of the present mark and the magnitude of the trailing space.

6. The adaptive writing method according to claim 5, wherein the light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

7. The adaptive writing method according to claim 6, wherein the light power for a predetermined channel is either read power or write power.

8. The adaptive writing method according to any of claims 1 to 7, further comprising the step of:

   (c) correcting the waveform of the adaptive write pulse in accordance with a land/groove signal indicating whether the input data is data of a land track or data of a groove track.

9. An adaptive writing method comprising the steps of:

   (a) selecting one of a plurality of grouping tables grouped by the magnitudes of mark and space of input data, using a grouping pointer;

   (b) calculating the width of a write pulse using the data stored in the selected grouping table; and

   (c) writing the input data using an adaptive write pulse generated responsive to the calculated width on an optical recording medium.

10. The adaptive writing method according to claim 9, wherein the grouping tables store width data of the first and/or last pulses of a write pulse waveform, by grouping the magnitude of the present mark of input data and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group and a long pulse group.

11. The adaptive writing method according to claim 9, wherein the grouping tables store width data of the first and/or last pulses of a write pulse waveform, by grouping the magnitude of the present mark of input data and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group and a long pulse group, depending on whether the input data is in a land track or a groove track.

12. The adaptive writing method according to claim 9, wherein the grouping tables store width data of the first and/or last pulses of a write pulse waveform, by grouping the magnitude of the present mark and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group and a long pulse group, for the respective zones on a recording medium.

13. The adaptive writing method according to any of claims 9 to 12, wherein the step (b) comprises the sub-steps of:

   (b1) reading a shift value of the rising edge of

the first pulse in accordance with a combination of the magnitude of the leading space and the magnitude of the present mark to calculate the width data of the first pulse; and

(b2) reading a shift value of the falling edge of the last pulse in accordance with a combination of the magnitude of the present mark and the magnitude of the trailing space to calculate the width data of the last pulse.

14. An adaptive writing method for use in writing input data onto an optical recording medium by a write pulse whose waveform comprises a first pulse, a last pulse and a multi-pulse train, for optimizing the light power of a light source, the adaptive writing method comprising the steps of:

(a) discriminating between the magnitudes of a present mark of input data and leading and/or trailing spaces;

(b) generating pulse width data for varying the widths of first and/or last pulses of the write pulse waveform in accordance with the magnitude of the present mark and the magnitudes of the leading and/or trailing spaces; and

(c) generating an adaptive write pulse in accordance with the pulse width data, converting the adaptive write pulse into a current signal in accordance with the driving power levels for the respective channels for the adaptive write pulse to drive the light source.

15. The adaptive writing method according to claim 14, wherein the step (b) comprises the sub-steps of:

(b1) generating first pulse width data for shifting the rising edge of the first pulse back and forth in accordance with the magnitude of the leading space and the magnitude of the present mark; and

(b2) generating first pulse width data for shifting the falling edge of the last pulse back and forth in accordance with the magnitude of the present mark and the magnitude of the trailing space.

16. The adaptive writing method according to claim 15, wherein the light power for a predetermined channel is applied during the period corresponding to the shift of the rising edge of the first pulse and during the period corresponding to the shift of the falling edge of the last pulse.

17. The adaptive writing method according to claim 16, wherein the light power for a predetermined channel is either read power or write power.

18. The adaptive writing method according to claim 14, further comprising the step of:

(d) correcting the waveform of the adaptive write pulse in accordance with a land/groove signal indicating whether the input data is data of a land track or data of a groove track, wherein the input data is NRZI (Non-Return Zero Inversion) data.

19. An adaptive writing circuit for use in an apparatus for writing input data onto an optical recording medium by a write pulse whose waveform comprises a first pulse, a last pulse and a multi-pulse train, the adaptive writing circuit comprising:

a discriminator (102) for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces;

a generator (104,108) for controlling the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse; and

a driver (110) for driving the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

20. The adaptive writing circuit according to claim 19, wherein the generator (104,108) includes a write waveform controller (104) for generating pulse width data for varying the width of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark and varying the width of the last pulse in accordance with the magnitude of the present mark and the magnitude of the leading space, and a write pulse generator (108) for generating an adaptive write pulse in accordance with the pulse width data.

21. The adaptive writing circuit according to claim 20, wherein the write waveform controller (104) comprises a memory in which width data of the first and/or last pulses of a write pulse waveform are stored, by grouping the magnitude of the present mark and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group and a long pulse group.

22. The adaptive writing circuit according to claim 21,

further comprising a microcomputer (106) for initializing the write waveform controller (104) and controlling the pulse width data stored in the memory to be updated in accordance with write conditions.

23. The adaptive writing circuit according to claim 21 or 22, wherein the memory stores width data of the first and/or last pulses of a write pulse waveform depending on whether the input data is in a land track or a groove track.

24. The adaptive writing circuit according to claim 21, 22 or 23 wherein the memory stores width data of the first and/or last pulses of a write pulse waveform for the respective zones on a recording medium.

25. The adaptive writing circuit according to any of claims 20 to 24, wherein the light power for a predetermined channel is applied during the period corresponding to the varied width of the first pulse and during the period corresponding to the varied width of the last pulse.

26. The adaptive writing circuit according to claim 25, wherein the light power for a predetermined channel is either read power or write power.

FIG. 1 (PRIOR ART)

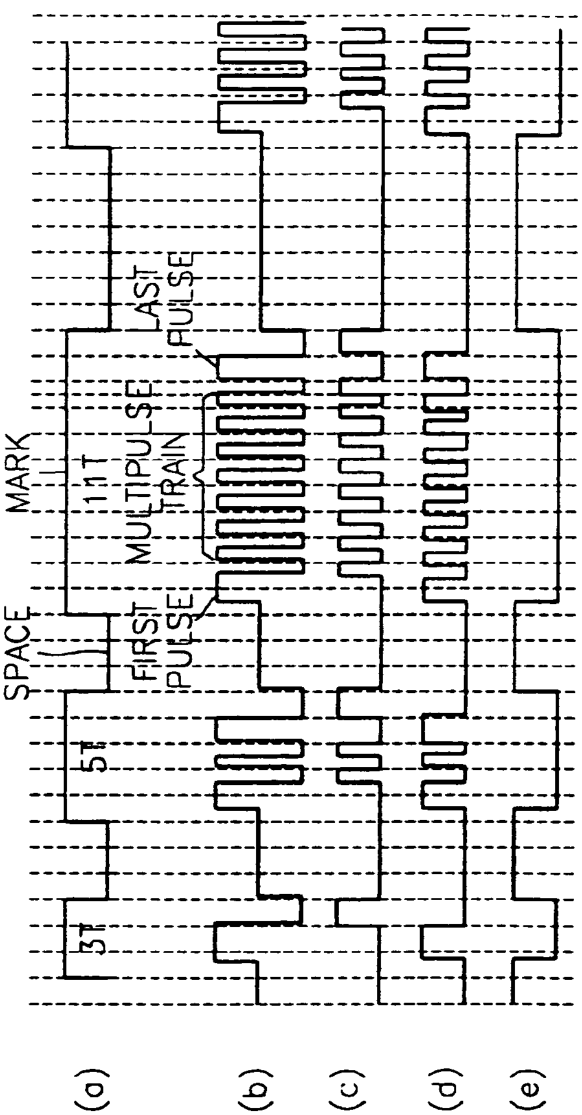


FIG. 2

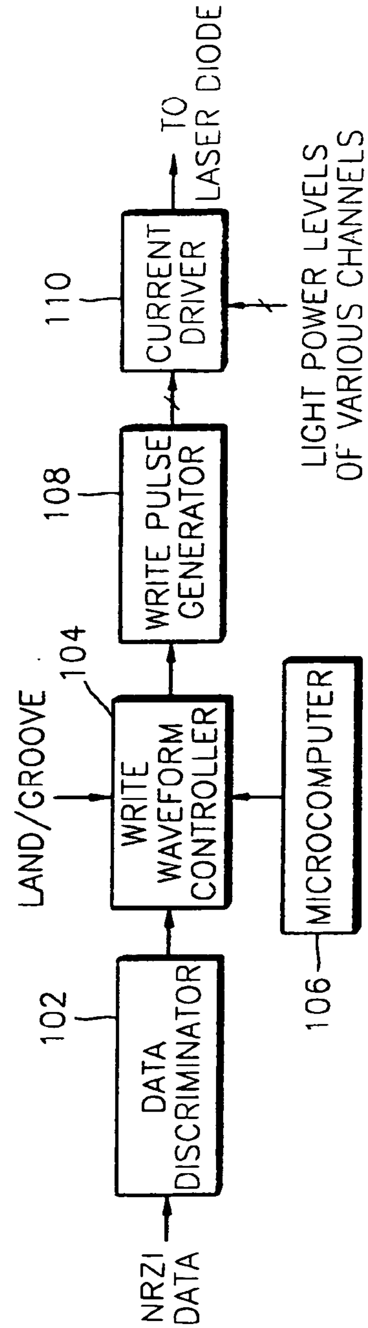
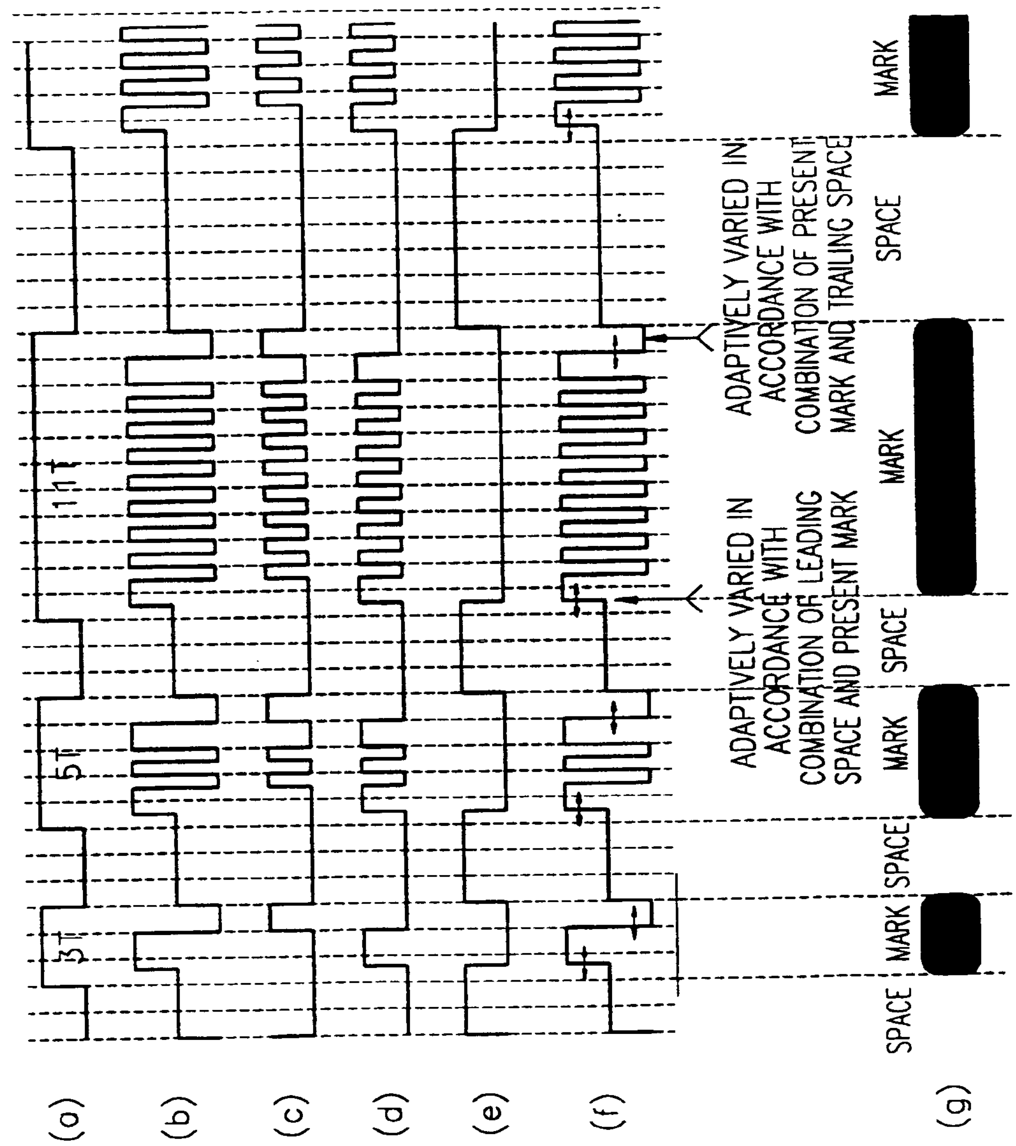


FIG. 3


(a)
(b)
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3T
5T
11T
SPACE
MARK
SPACE
MARK
SPACE
MARK
SPACE
MARK
ADAPTIVELY VARIED IN ACCORDANCE WITH COMBINATION OF LEADING SPACE AND PRESENT MARK
ADAPTIVELY VARIED IN ACCORDANCE WITH COMBINATION OF PRESENT MARK AND TRAILING SPACE

FIG. 4

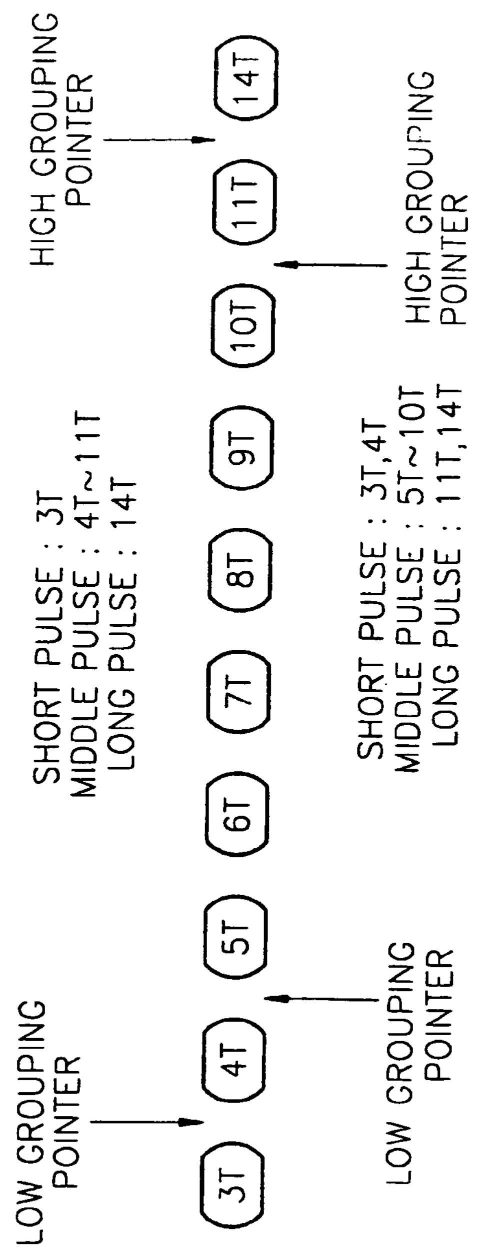

LOW GROUPING POINTER
SHORT PULSE : 3T
MIDDLE PULSE : 4T~11T
LONG PULSE : 14T
HIGH GROUPING POINTER
3T
4T
5T
6T
7T
8T
9T
10T
11T
14T
LOW GROUPING POINTER
SHORT PULSE : 3T,4T
MIDDLE PULSE : 5T~10T
LONG PULSE : 11T,14T
HIGH GROUPING POINTER

FIG. 5

LEADING SPACE	PRESENT MARK	TRAILING SPACE
SHORT PULSE	SHORT PULSE	SHORT PULSE
SHORT PULSE	SHORT PULSE	MIDDLE PULSE
SHORT PULSE	SHORT PULSE	LONG PULSE
SHORT PULSE	MIDDLE PULSE	SHORT PULSE
SHORT PULSE	MIDDLE PULSE	MIDDLE PULSE
SHORT PULSE	MIDDLE PULSE	LONG PULSE
SHORT PULSE	LONG PULSE	SHORT PULSE
SHORT PULSE	LONG PULSE	MIDDLE PULSE
SHORT PULSE	LONG PULSE	LONG PULSE
MIDDLE PULSE	SHORT PULSE	SHORT PULSE
MIDDLE PULSE	SHORT PULSE	MIDDLE PULSE
MIDDLE PULSE	SHORT PULSE	LONG PULSE
MIDDLE PULSE	MIDDLE PULSE	SHORT PULSE
MIDDLE PULSE	MIDDLE PULSE	MIDDLE PULSE
MIDDLE PULSE	MIDDLE PULSE	LONG PULSE
MIDDLE PULSE	LONG PULSE	SHORT PULSE
MIDDLE PULSE	LONG PULSE	MIDDLE PULSE
MIDDLE PULSE	LONG PULSE	LONG PULSE
LONG PULSE	SHORT PULSE	SHORT PULSE
LONG PULSE	SHORT PULSE	MIDDLE PULSE
LONG PULSE	SHORT PULSE	LONG PULSE
LONG PULSE	MIDDLE PULSE	SHORT PULSE
LONG PULSE	MIDDLE PULSE	MIDDLE PULSE
LONG PULSE	MIDDLE PULSE	LONG PULSE
LONG PULSE	LONG PULSE	SHORT PULSE
LONG PULSE	LONG PULSE	MIDDLE PULSE
LONG PULSE	LONG PULSE	LONG PULSE

FIG. 6

LEADING SPACE	PRESENT MARK	RISING EDGE SHIFT OF FIRST PULSE(nS)
SHORT PULSE	SHORT PULSE	+1
SHORT PULSE	MIDDLE PULSE	−1
SHORT PULSE	LONG PULSE	−3
MIDDLE PULSE	SHORT PULSE	+2
MIDDLE PULSE	MIDDLE PULSE	0
MIDDLE PULSE	LONG PULSE	−2
LONG PULSE	SHORT PULSE	−3
LONG PULSE	MIDDLE PULSE	−1
LONG PULSE	LONG PULSE	0

FIG. 7

PRESENT MARK	SPACE MARK	FALLING EDGE SHIFT OF LAST PULSE(nS)
SHORT PULSE	SHORT PULSE	+1
MIDDLE PULSE	SHORT PULSE	+2
LONG PULSE	SHORT PULSE	+4
SHORT PULSE	MIDDLE PULSE	−1
MIDDLE PULSE	MIDDLE PULSE	0
LONG PULSE	MIDDLE PULSE	+1
SHORT PULSE	LONG PULSE	−3
MIDDLE PULSE	LONG PULSE	−1
LONG PULSE	LONG PULSE	0

FIG. 8

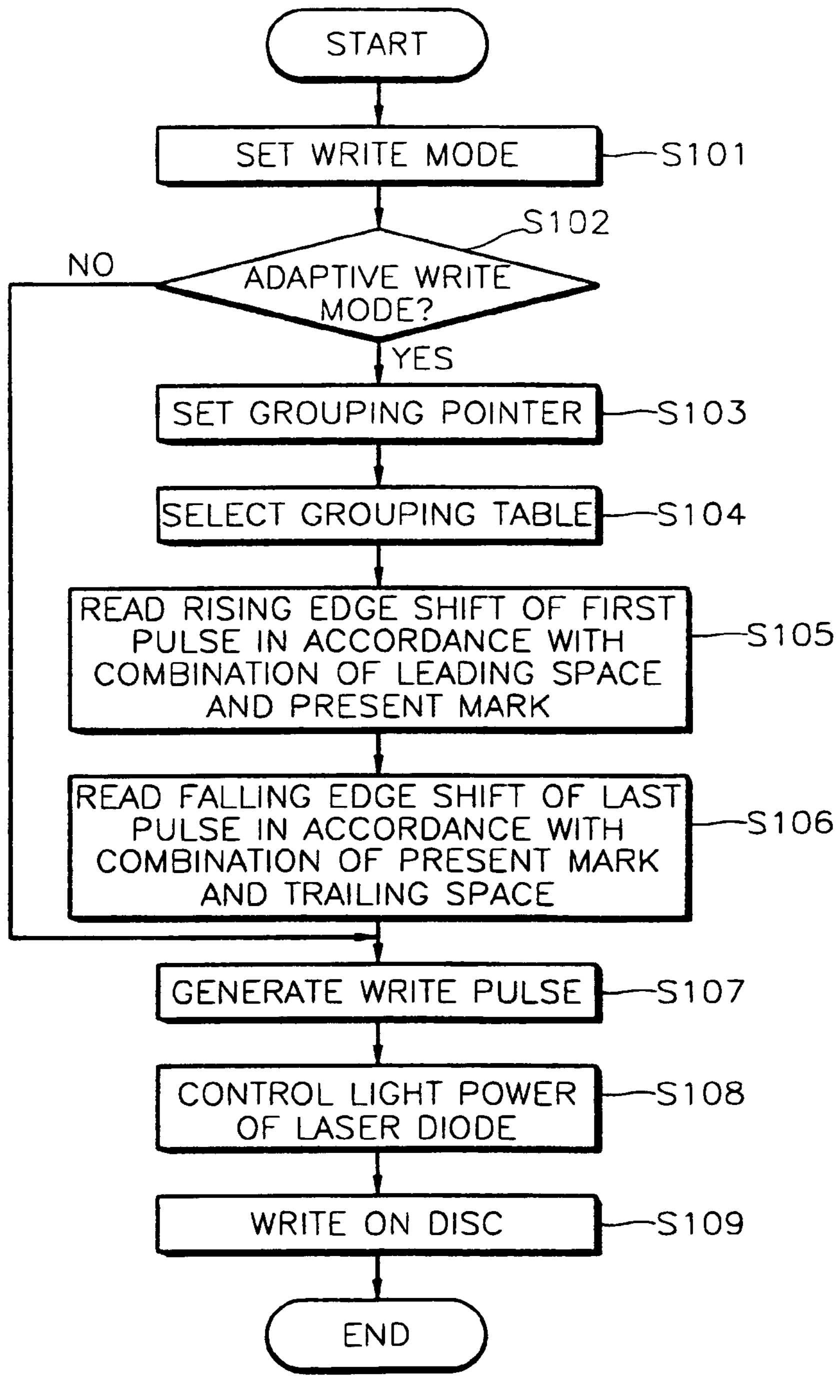
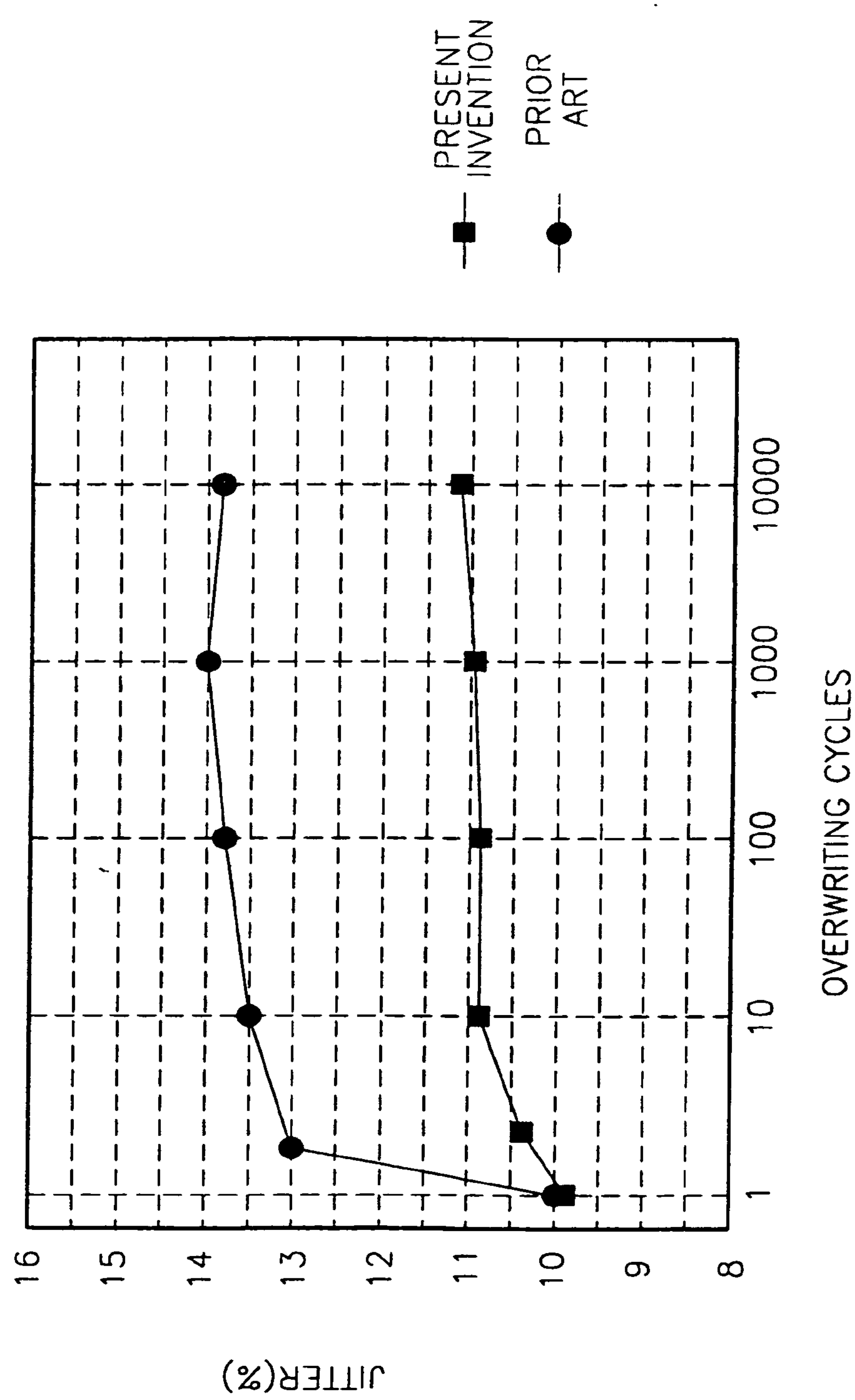

START
SET WRITE MODE
S101
S102
ADAPTIVE WRITE MODE?
NO
YES
SET GROUPING POINTER
S103
SELECT GROUPING TABLE
S104
READ RISING EDGE SHIFT OF FIRST PULSE IN ACCORDANCE WITH COMBINATION OF LEADING SPACE AND PRESENT MARK
S105
READ FALLING EDGE SHIFT OF LAST PULSE IN ACCORDANCE WITH COMBINATION OF PRESENT MARK AND TRAILING SPACE
S106
GENERATE WRITE PULSE
S107
CONTROL LIGHT POWER OF LASER DIODE
S108
WRITE ON DISC
S109
END

FIG. 9


PRESENT INVENTION
PRIOR ART
JITTER(%)
16
15
14
13
12
11
10
9
8
1
10
100
1000
10000
OVERWRITING CYCLES